Using the GreenIndex+ Smartphone App to Measure Dark Green Color Index (DGCI) in Corn

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Abstract

One parameter used to help compute sidedress nitrogen recommendations is leaf greenness, which is a proxy for chlorophyll content, and thus plant nitrogen status. There are a number of optical tools that use pre-selected wavelengths of light in the red and infrared bands and generate a greenness index (SPAD number, NDVI, ...). Recent work has shown that color images taken with digital cameras can be processed with PC-based software to produce a Dark Green Color Index (DGCI) that correlates well with existing indexes. Proper color processing requires a neutral (pink) background with yellow and green color standards to properly account for different light levels. The GreenIndex+ system adapts this technology as an App for the iPod, iPhone, and iPad. DGCI results are available immediately and can be geo-referenced using the device's internal GPS receiver. Data transfer is accomplished via an attached e-mail file. The GreenIndex+ provides a relatively low-cost alternative for estimating relative N status of plants. The resulting DGCI can be calibrated to guide sidedress and other in-season supplemental N fertilizer applications.

Introduction

- There are a wide variety of instruments that use wavelengths of red and infrared light to compute greenness indexes such as SPAD value or NDVI.
- Karcher and Richardson[1] found that color digital photographic images (DSLR camera) could be processed to quantify a greenness index that was correlated to turf health.
  - Required transforming the red, green, blue (RGB) data into the hue, saturation, brightness (HSB) color space
  - Created the Dark Green Color Index (DGCI) computed from HSB values

$$DGCI = \frac{1}{3}\left[\frac{Hue - 60}{60} + (1 - Saturation) + (1 - Brightness)\right]$$

- Adapted for use in corn by Purcell et al[2].
  - Required pink board/color standards for leaf measurements
  - Field testing showed correlation to SPAD and leaf nitrogen concentration

Adaptation for SmartPhone (iPod, iPhone)

- Confirmed compatibility of iPod camera
- Quality is sufficient (vs DSLR camera)
- App DGCI matched SigmaScan DGCI
- White balance adjustment included
- Use touchscreen to identify measurement regions rather than programmatically finding them using PC-based image analysis
- User-friendly Board
- Adapted for single user (small, hand strap)
- Chose color materials to avoid metamerism (changing of color appearance due to angle of incident light).

Testing/Results

- Data consistent for consecutive readings of individual leaves by multiple users (Fig. 1).
- Locking smart device's white balance improved accuracy (Fig. 2).
- Ongoing field testing in wheat and corn.

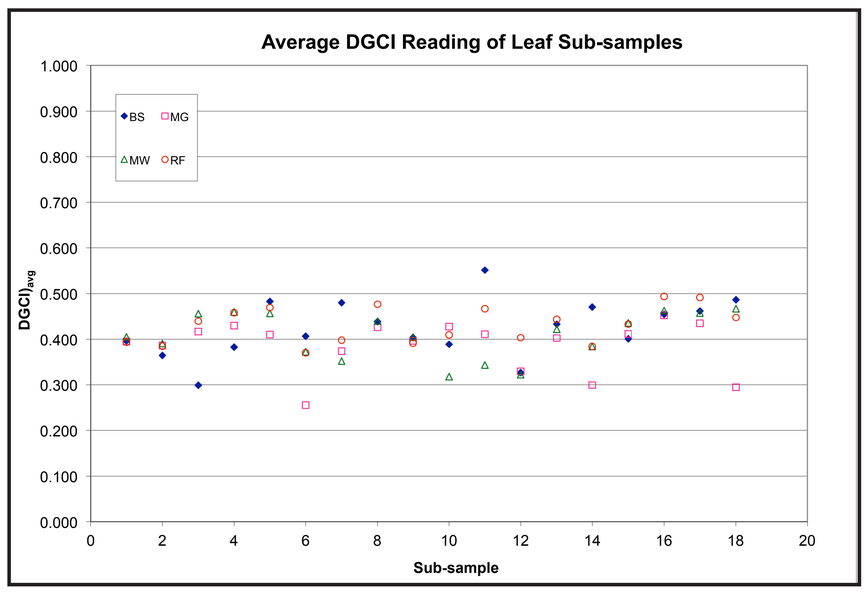

Figure 1. Average of multiple GreenIndex+ readings of plant sub-samples taken by 4 testers.

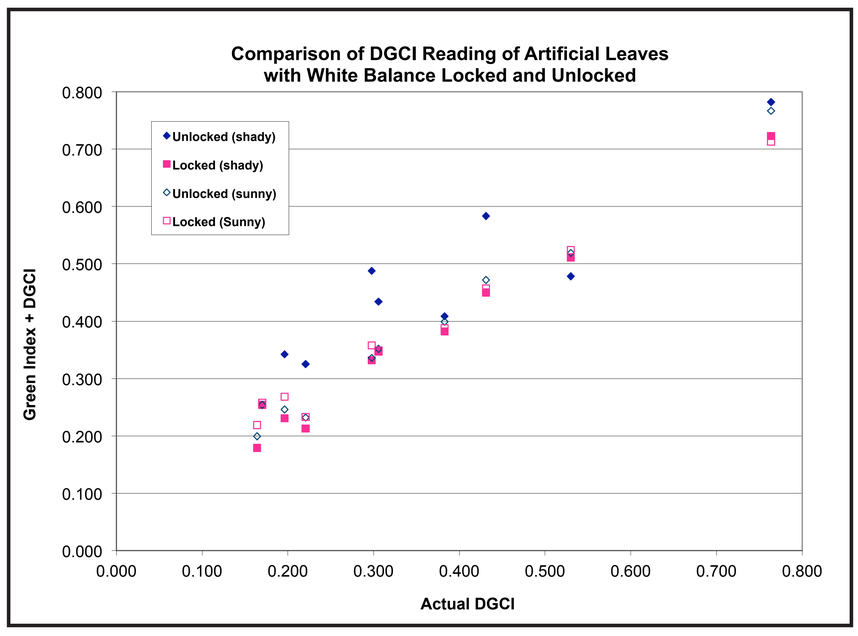

Figure 2. Comparison of GreenIndex+ readings taken with and without locking camera white balance feature.

References

[1] Karcher, D.E.,and M.D. Richardson. 2003. Quantifying turfgrass color using digital image analysis. Crop Sci. 43:943-951.

[2] Rorie, R.L., L.C. Purcell, D.E. Karcher, and C.A.King.. 2011. The assessment of leaf nitrogen in corn from digital images. Crop Sci. 51:2174-2180.